SUBJECTIVE TIME SAVINGS IN INTERURBAN TRAVEL: AN EMPIRICAL STUDY

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Travel time savings are usually estimated on the basis of objective measures of time. Such objective measures are assumed to correspond to the mean of a distribution of subjective time savings as reported by travelers. In a multimodal, single-route, interurban passenger survey carried out in Israel, that was not found to be the case. Each passenger was requested to report separately time differences by mode and time savings. When the replies were compared, it appeared that 21 percent of air passengers stated that their time savings amounted to quantities nearly twice as much as the mean of the difference in reported travel times. When asked how much time they would have saved traveling by air, 16 percent of all bus passengers indicated the same discrepancy between differences in time spent and time saved. A group of large time savers, as compared with normal time savers, was identified with a distinctive profile of trip attributes but not of socioeconomic attributes. Large time savers are those passengers who reported twice as much time savings as the differences in time spent by mode. Possible reasons for the bimodal distribution of time savings have been sought in the perception of the choice situation generally facing the traveler, or, alternatively, in the special conditions of trips across a desert. It is recommended to clarify the generality of the results by means of additional surveys of similar design.

•THE COMMON observable fact that time has opportunity costs is probably best seen in the purchase of fast but costlier transportation services. Not surprisingly, mode choice studies have been used as a prime tool to determine the value of travel time as perceived by the individual decision-maker.

The basic assumption is that each transportation technology has 2 prime choice attributes: speed and cost. If for every journey having a given origin and destination at least 2 different routes or modes can be chosen, then, other things being equal, the selection will be made on the basis of the value of time of the traveler. People with a low value of time will choose the slower route or mode, and people with the higher value of time will choose the faster and more expensive route or mode.

Additional assumptions relate to the strict applicability of market place conditions to the travel mode choice situation. Rationality in the choice-making, full-information, and freedom of choice are usually included here. A more intractable problem concerns the fact that transportation services are actually joint products, combining capacity and quality of service. So far, no way has been found to treat the comfort side of the product adequately.

The present study is concerned with the empirical investigation of the assumption that interview respondents are able to perceive accurately the objective travel time that they face in a choice situation. Stated alternatively, the same assumption claims that there is a consistent relationship between objective time data as derived from engineering assignments and the perceived estimates of time consumed in travel. The

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simplest situation would be that in which random errors in estimation are distributed normally around an average close to the objective time. In the case of the Skokie study (1, 2), it has been found that such simple situations do indeed occur, when travelers were asked on time spent on a commuter trip, though without being asked as to their estimate of time differences or time savings by mode.

It is suggested that estimations of travel time by travelers differ from objectively measured times in at least one aspect. Whereas measured times can be obtained repeatedly within a narrow confidence limit, irrespective of the distance traveled, travel time estimations by travelers might be affected by trip distances. Time estimations of interurban trips, unlike commuting, may be systematically biased for a variety of reasons: the perception of distant locations in the real world, preference scales of the various transportation modes, and time savings of greater magnitude measured by hours rather than fractions of hours. All of these could cause significant and consistent discrepancies between measured and estimated travel times.

In this paper, "subjective" time refers both to travel time differences by mode and to travel time savings, provided that both are based on estimations by travelers. "Objective" time, on the other hand, is determined by the unbiased measurement of the time consumed by mode on the basis of the performance of each mode. The point that will be made is that subjective time differences may differ substantially from subjective time savings. Consequently, a significant error may be introduced if estimations of travel time savings are based on objective measurements of differences in time consumed by mode.

More specifically, if subjective travel time savings estimates were to differ substantially from objectively measured time savings, the current state of the art in determining the value of travel time would be affected (3). Moreover, recent findings (4, 5) seem to indicate that the value of travel time is a function of the amount of time saved. Biased travel time estimations would then result in even greater errors in determining the value of time saved.

FINDINGS OF PREVIOUS STUDIES

The first indication of significant differences between objectively measured and subjectively reported time savings was found in a week-long air passenger survey carried out in Israel in November 1967 (6). All air travelers between Tel Aviv and Elat were asked to report on a questionnaire how much time, in their opinion, they saved by traveling by air instead of by ground transportation. For an adjusted subsample of travelers with origins and destinations within 5 miles of the airports, objective time savings were determined to average between 5 and 6 hours.

Rather than the expected normal frequency distribution or replies, averaging around 5 to 6 hours, the results showed a clear bimodal frequency distribution. About 50 percent of the travelers replied that they saved amounts similar to those that may be surmised from a probability distribution curve around the objective time difference between the modes. However, the other half of the subsample population replied that it had saved twice as much time, namely, a day or more. It should be noted that no 1-day round trips were included in the subsample.

In the subsequent analysis of the results, a number of questions could not be satisfactorily resolved because of the lack of sufficient data. The interpretation of possible reasons for the bimodal distribution was inconclusive, particularly because a number of alternative explanations could be made. To begin with, the information basis of the interviewed passengers was unknown. There was no indication whether the passengers had a correct knowledge of the objective times involved; hence, there is the possible existence of a perception bias (7). Similarly, even if it were assumed that the information basis was adequate, there still remained a reasonable explanation, in terms of an antimodal bias, for the excessive amount of time saved reported. In other words, because air travelers completed all questionnaires, they may have wished to exaggerate the advantages of the chosen over the rejected mode.

A repetition of the inquiry in the field was, clearly, both necessitated and justified by the partial results of the 1967 survey. This time, however, special attention was

to be given to the design of the questionnaire and of the sample. In this way, it was hoped to isolate the effects of the perception and antimodal biases from other possible explanations for discrepancies between measured and estimated travel time savings.

THE SURVEY OF NOVEMBER 1970

In November 1970, the Israel Ministry of Transport carried out a field survey to determine the price of time as perceived by interurban passengers (8). As before, the choice situation consisted of mode, rather than route selection: All persons traveling between Elat and the rest of the country were required to complete a questionnaire. The alignment of bus routes was kept as close as possible to reality; thus, the number of buses leaving for Tel Aviv is larger than the number going in the other direction (Fig. 1). The survey lasted 7 days, but the seventh day had subsequently to be discounted because flash floods disrupted the single overland transportation link. The total number of questionnaires returned in 6 days was about 7,000; about 6,000 were suitable for analysis (9). The rate of response reached 90 percent.

Two main modifications were introduced in the 1970 survey. First, 3 modes were investigated instead of 1: all regular air services, all regular bus services, and all occupants of private vehicles. Modal split of the sample population is given in Table 1.

Second, the questionnaire included more than a single question relating to time estimation. One question remained roughly in its former wording. Only this time, bus passengers as well as air passengers were asked how much time they thought they would have saved by flying instead of going by bus. The second set of questions intended to reveal the information basis of the various time attributes by mode.

Hence, the following question was asked, How long do you think it would take to make this trip by bus, by car, by air? Passengers were asked to answer to all listed modes. It was assumed that, by the subtraction of time consumed by air from time consumed by bus or car, the information basis of the decision-maker as to mode attributes and spatial perception would emerge independently from subjective estimations of time savings reported in the first question.

DISCUSSION OF FINDINGS

The principal hypotheses with regard to the expected distribution of replies may be stated as follows:

1. The distribution of replies related to time saving estimation will be bimodal, irrespective of the means of transportation used—the first mode will average around 5 hours, and the second will be twice that magnitude or more; and
2. The distribution of replies to the question on travel time estimation by mode (or information variable) is likely to be normal for each transportation mode, with a possible shift of the value of the mean according to the transportation mode used.

Preliminary results (Tables 2 and 3) indicate that both hypotheses may be accepted. Of particular interest are the frequencies of replies in the category of 12 and more hours (Table 2). Disregarding those passengers who did not reply, 21 percent of total air passengers and 16 percent of total bus passengers stated that they saved (or would have saved) 12 or more hours. In the subsample of Elat residents, that proportion is even higher, 28 and 23 percent respectively.

The results (Table 3 and Fig. 2) reveal the existence of a normal distribution, with a shift of the mode and median according to the transportation mode used. Thus, the mode for air passengers is 5 hours of time differences between air and bus, and the median is slightly more. For bus passengers, the mode is also 5 hours, and the median is slightly less. Car passengers, as expected, estimated time differences to be far less; the mode is only 4 hours, and the median is even less. An interesting corroboration of these antimodal biases is found in the distribution replies by the Elat residents, who are assumed to have a greater knowledge and experience regarding the times involved. In all cases, the differences as given by Elatis accentuate the mode and median difference but do not affect the basically normal distribution.

Figure 1. Transportation services and routes to Elat.

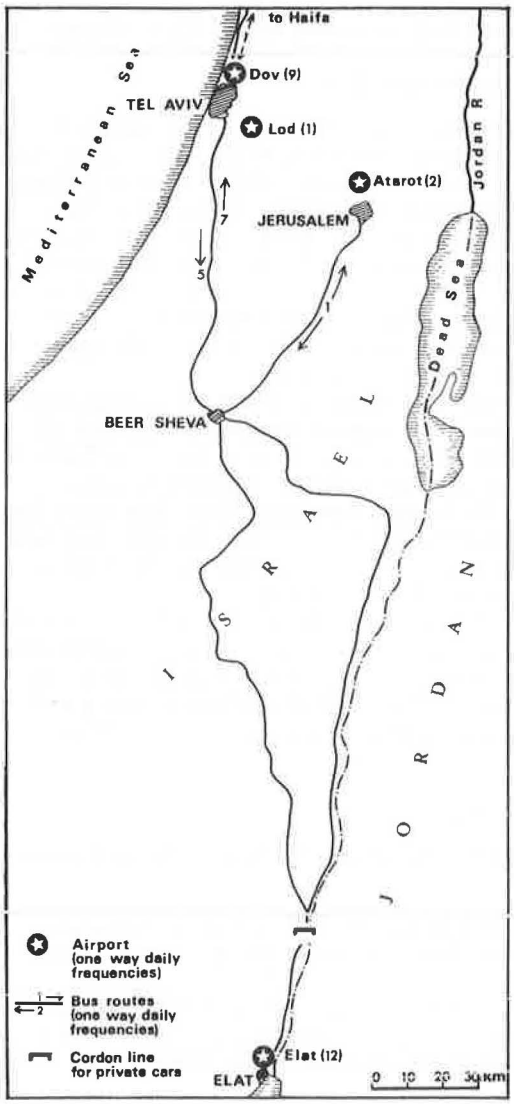
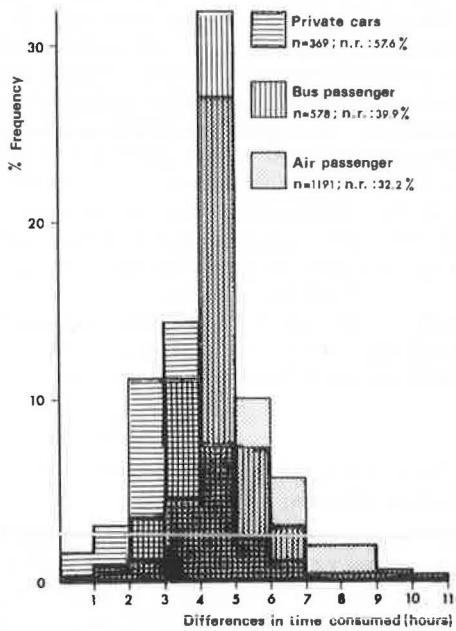


Table 1. Modal split of Elat survey.

Mode	Total Replies		Usable Replies	
	Number	Percent	Number	Percent
Air	4,036	57	3,811	64
Bus	2,141	31	1,451	26
Private vehicles	962	12	644	10
Total	7,139	100	5,906	100

Note: Does not include Saturday, October 31, because no public transportation operates on Saturday. Also, replies given on November 6 were not included, because overland routes were flooded and traffic was interrupted.

Figure 2. Passengers' estimation of differences in time by transportation mode.



The data were subsequently checked to ascertain that respondents replied to both time-related questions—the first about estimates of time saved and the second about estimates of time consumed by each mode. On the basis of this analysis, 2 populations were separated: group A, a subpopulation that reported time savings of similar magnitudes to the differences in time consumed; and group B, a subpopulation that reported time savings far in excess of their reported time differences by mode. More specifically, group A included all respondents with savings of 12 hours or fewer, and group B included all respondents who estimated their time savings as more than 12 hours, a day, and more than a day. Group A included 3,255 respondents, and Group B included 821 respondents. Travelers who did not reply to both questions were excluded at this stage.

It is proposed that the existence of the 2 populations can be related to the nature of transportation demand, sometimes defined as derived demand (10). The purpose of a trip, which is one of the main determinations of the decision as to whether to make a displacement, is usually to perform another activity at the trip end. Thus, it is possible that decision-makers might assess the savings of time of a trip not just in terms of the attributes of a given transportation technology, such as speed, but also in terms of the amount of time left at either trip end for the completion of the activity that generated the trip. For example, in the case of the Elat-Tel Aviv route, a 5-hour trip by surface transportation will in some cases mean the disruption of a full working day. The distinction between the 2 groups of travelers might therefore lie in the perception of the choice situation when travel time can be saved.

Most people might perceive the choice in the strict sense, that is, between 2 alternative technologies. For the other group, the choice situation is broader because other activities, besides traveling, are being considered. Whenever technological time savings become large, such as 4 to 6 hours as in this case, it can be assumed that the difference between the 2 perceptions of the choice situation would be substantial.

Another reason for the large difference in time saving could be the result of spatial perception biases rather than perception of choice-making situations. The trip to Elat involves the crossing of a large desert area, so that travelers might conceivably feel that the advantage of flying over the desert rather than driving across it is equivalent to the saving of much more time. The general case would be that origins and destinations of trips might affect the estimation of time savings.

On the basis of these propositions, each group was characterized by a profile consisting of 3 elements: socioeconomic properties, trip properties, and spatial properties. It is suggested that large time savers, namely group B, have distinctive profiles of trip and spatial characteristics, though not necessarily in their socioeconomic properties. The 2 profiles are given, by means of selected representative values, in Table 4.

It appears that the 2 groups have similar socioeconomic characteristics but show large differences in their trip characteristics. As for spatial properties, both properties seem to differ although that of the general origin and destination distribution of trips is slightly less significant. A typical profile or a large time saver is likely to be a resident of Elat who is traveling by air to a large city for work purposes and who, preferably though not necessarily, will return on the same day.

CONCLUSIONS

On the basis of the empirical results analyzed so far, it has been shown that differences between objective and subjective amounts of time saved do exist. Those differences are not just the expression of information or antimodal perception biases, although those have been found to occur. A group of passengers has been identified that consistently estimated time savings at least twice as large as the usual objective differences in travel times.

It may be tempting to discuss the implications of these results for modal-split modeling, disaggregate behavior models, or the evaluation of travel time savings. However, it is felt that such an interpretation of the results is premature.

Two problems in particular await further clarification by additional surveys of similar design in other parts of the world. First, it has to be established whether the

Table 2. Time savings by transportation mode and residence.

	Air Passengers				Bus Passengers			
	All		Elat Residents		All		Elat Residents	
Hours	Number	Percent	Number	Percent	Number	Percent	Number	Percent
0 to 2	112	3.0	36	3.6	57	3.9	12	3.7
2 to 4	327	8.8	77	7.6	146	10.1	37	11.4
4 to 6	829	22.1	192	18.9	380	26.2	72	22.2
6 to 9	346	9.3	68	6.7	70	4.8	12	3.7
9 to 12	206	5.6	43	4.2	57	3.9	7	2.2
12 to 18	28	0.8	5	0.5	6	0.4	0	0.0
18 to 24	18	0.5	4	0.4	6	0.4	1	0.3
24 to 48	184	4.9	73	7.2	71	4.9	18	5.6
None specified								
Less than a day	534	14.3	146	14.4	222	15.3	34	10.5
More than a day	405	10.9	139	13.7	97	6.7	34	10.5
No reply	738	19.8	231	22.8	339	23.4	97	29.9
Total	3,727	100.0	1,014	100.0	1,451	100.0	324	100.0

Note: Time saving estimation was derived directly from the question, How much time do you think you saved (for bus, you would have saved) by flying instead of going by bus? For reasons of comparability with previous surveys, passengers with origins or destination in Sinai have been excluded.

Table 3. Differences in time by transportation mode and residence.

	Air Passengers				Bus Passengers				Private Car			
Difference in Time by Air and Bus (hours)	All		Elat Residents		All		Elat Residents		All		Elat Residents	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
0	9	0.2	6	0.6	0	0.0	0	0.0	2	0.3	0	0.0
1	17	0.5	1	0.1	3	0.2	1	0.3	8	1.2	2	1.6
2	42	1.1	21	2.1	12	0.8	3	0.9	20	3.1	5	4.0
3	168	4.6	53	5.2	55	3.8	17	5.2	74	11.5	16	12.7
4	471	12.7	158	15.6	165	11.4	42	12.9	95	14.8	14	11.1
5	1,019	27.4	306	30.2	465	32.1	91	28.2	49	7.6	5	4.0
6	383	20.4	14	11.2	111	7.6	26	8.0	17	2.6	2	1.6
7	219	5.9	33	3.6	45	3.1	8	2.5	8	1.2	0	0.0
8	76	2.0	9	0.9	6	0.4	1	0.3	2	0.3	0	0.0
9	73	2.0	5	0.5	3	0.2	0	0.0	0	0.0	0	0.0
10	27	0.7	3	0.3	5	0.3	2	0.6	0	0.0	0	0.0
11	15	0.4	2	0.2	3	0.2	1	0.3	0	0.0	0	0.0
12	5	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
13	3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
14	2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
15	3	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
16	2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
17	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
18	2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
No reply	1,191	32.0	298	29.4	578	39.9	132	40.8	369	57.4	82	65.0
Total	3,727	100.0	1,014	100.0	1,451	100.0	324	100.0	644	100.0	126	100.0

Note: Computed from the question, How long do you think it would take to make this trip by bus, by air, by car? and subtracting the time of the fastest mode from the slowest.

Table 4. Profiles of time-saving groups by main properties.

Item	Group A	Group B
Number of cases	3,255	821
Socioeconomic properties		
Age 22 to 40, percent	59.1	60.4[a]
Monthly income I£ 601 to 2,000, percent	47.9	52.6[a]
Trip properties		
Bus travelers, percent	37.8	22.2[b]
Work-recreation ratio	0.56	0.89[b]
Return same day, percent	12.1	24.2[b]
Spatial properties		
Elat residents, percent	27.4	38.2[b]
Origins and destinations in Tel Aviv, Jerusalem, Haifa, percent	84.0	81.1[c]

[a] Difference between groups not significant.
[b] Difference significant at 99.91 percent.
[c] Difference significant at 99 percent.

group of large time savers found in the Elat case represent a general case of the perception of the choice situation in a broader sense or merely represent a unique example of a particular spatial bias affecting desert towns. The other problem relates to the stability of the perception over time and space. Here again, highly divergent outcomes may be hypothesized and, therefore, require further investigation.

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